Scanning Electron Microscopy Scheme

BACKGROUND

This report covers Round 9 of the SEMS asbestos fibre counting PT scheme. The scheme is operated by HSE, in collaboration with APC, Germany and TNO, Netherlands.

SAMPLES

Four samples were circulated representing a range of different fibre densities and fibre types. All samples were produced at HSE using the modified sputnik multi-port sampling instrument.

INTRODUCTION

A total of 52 laboratories participated in this round (including the validating laboratories). Laboratories were able to submit up to three results per sample and many laboratories took advantage of this with a total of 354 results submitted.

The samples were as follows:

9SEM1 – Low density (9.5 fibres/mm^2) - amosite fibres

9SEM2 – Medium density (39.9 fibres/mm^2) - amosite fibres

9SEM3 – Medium density (27.3 fibres/mm^2) - amosite fibres

9SEM4 – Medium density (48.9 fibres/mm^2) - amosite fibres

INFORMATION SUBMITTED BY LABORATORIES

Laboratories were asked to supply the following information:

- Number of fibres >5μm in length counted (amphibole, chrysotile & other inorganic)
- The number of fields of view searched
- The area of the field of view
- The magnification and the method used

Laboratories were asked to calculate the fibre density (in fibres/mm^2) for each fibre type identified.

LABORATORY ASSESSMENT

RESULTS

Calculations – No errors were identified in this round.

Screen area – The fibre densities submitted by laboratories have not been recalculated and the density calculation and therefore screen area has not been verified.

Magnification – As was the case in earlier rounds, some laboratories used an operating magnification outside the range defined in ISO 14966 (or VDI 3492).

Magnifications of 4000x, 3000x, 2000x and 1000x were recorded.

Results for total asbestos fibre densities for each laboratory are summarised in Appendix 1.

Data Analysis

Data analysis is based upon the total asbestos fibre densities (amphibole & chrysotile) derived from fibre numbers counted and the area of the filter searched. The distribution of fibres on a filter derived from airborne sampling is normally described as being Poisson-distributed. For Poisson-distributed counts, the variance (standard deviation squared) is equal to the mean. However, in practice the variation may be larger due to differences in sample production, laboratories and individual microscopists.

A comparison of the observed standard deviations with the expected standard deviations (expected under Poisson distribution) show that the observed variation is larger than that expected, and it is difficult to quantify how much of this may be due to differences in sample production, and how much is due to differences between labs/microscopists.

For this report, the data have been compared against the criteria used in the UK phase contrast fibre counting proficiency testing scheme RICE. Details of the analysis used can be found in Appendix 2.

Round 9 Overview

Summary statistics from this round of results are displayed in Table 1. Below this, Figure 1 displays the percentage of participants in each scoring band (as per the RICE scoring system). Figures 2 and 3 show the band scored by participants divided according to magnification and method used respectively.

Table 1: Summary statistics for results received in SEMS Round 9

	Sample 1	Sample 2	Sample 3	Sample 4
Number of results	89	89	88	88
Median (fibres/mm^2)	9.5	39.9	27.3	48.9
25th percentile (fibres/mm^2)	7.6	33.3	20.9	39.9
75th percentile (fibres/mm^2)	13.9	48.1	33.4	61.1
Interquartile range (fibres/mm^2)	6.3	14.8	12.5	21.2
Mean (fibres/mm^2)	10.2	41.3	27.8	49.1
Standard deviation (fibres/mm^2)	3.9	14.5	10.1	19.0
Relative standard deviation (%)	37.9	35.1	36.2	38.6

Note: The relative standard deviation (RSD) is calculated by (standard deviation/mean)*100%. This statistic illustrates the variation relative to the size of the mean value. For very low values of the mean, the value of the RSD can be considered largely meaningless.
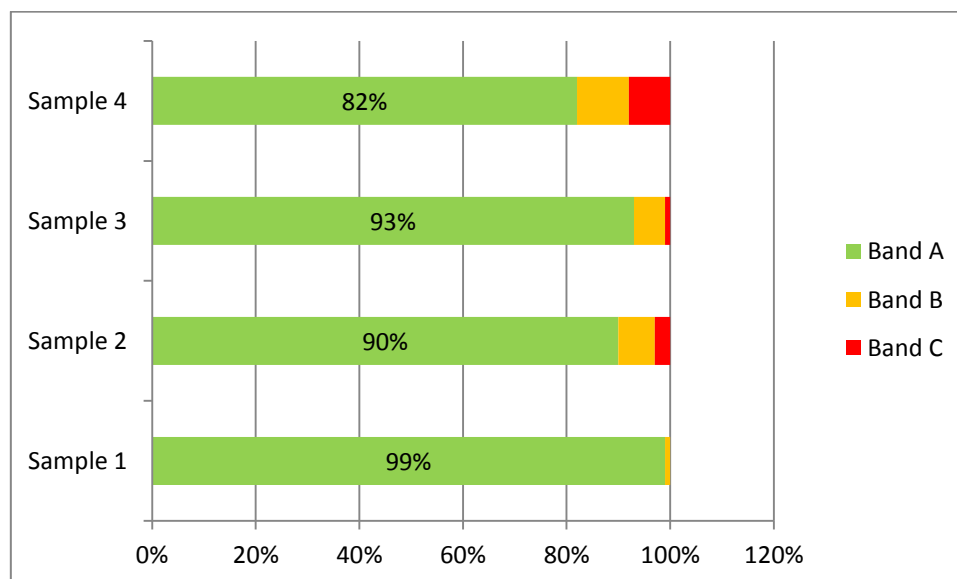
*Figure 1: Banded scores for participants in SEMS Round 9
(categorised as per RICE scoring system - see Appendix 2)*

Figure 2: Banded scores for participants in SEMS Round 9 divided according to method used
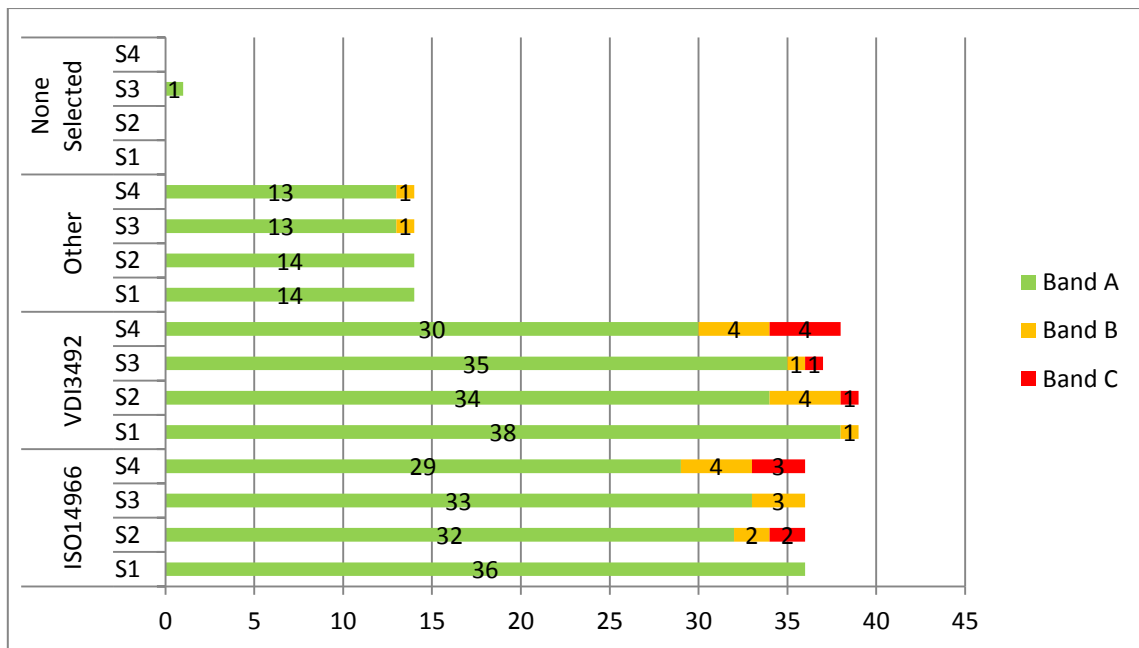
Figure 3: Banded scores for participants in SEMS Round 9 divided according to magnification use
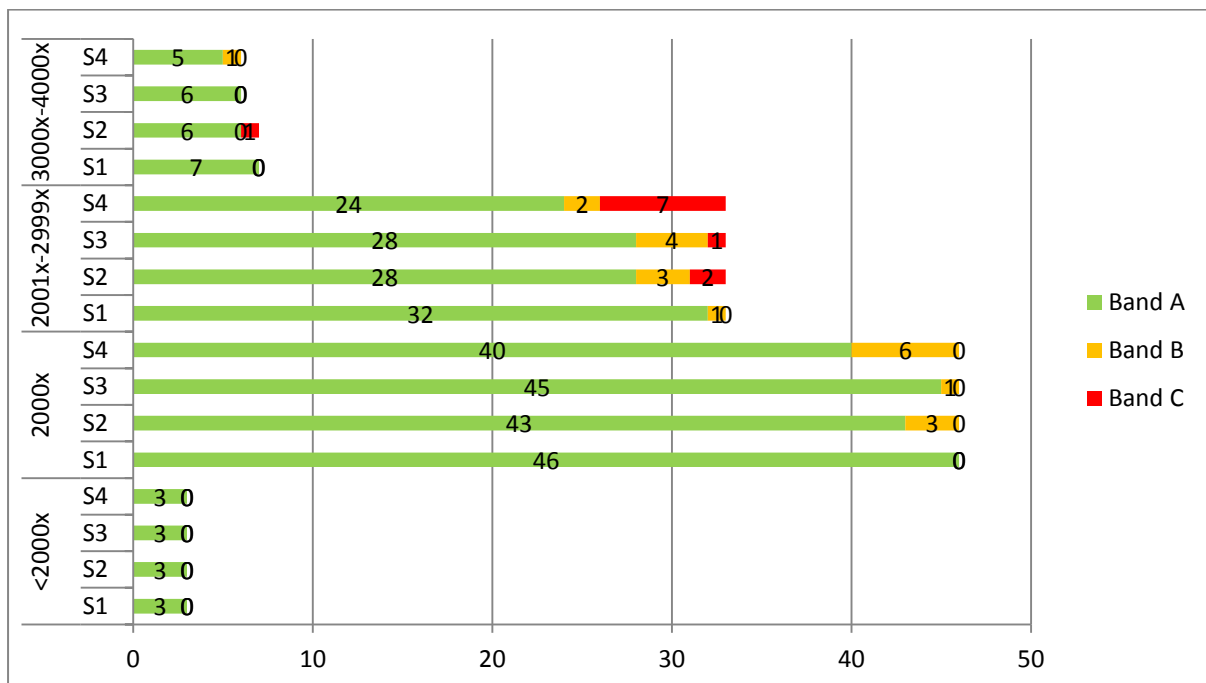
APPENDIX 1

Sample 1 (9SEM1) - Low density (9.5 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	10.3	A
7	13.3	A
139	9.5	A
139	14.0	A
300	15.0	A
709	7.5	A
807	9.9	A
807	7.0	A
818	8.0	A
1181	14.4	A
1187	7.7	A
1267	8.0	A
1445	18.0	A
1456	15.2	A
1458	10.6	A
1458	7.7	A
1458	8.2	A
1507	12.9	A
1546	5.0	A
1558	9.0	A
1562	8.5	A
1569	10.5	A
1575	5.5	A
1575	3.7	A
1575	7.3	A
1576	11.4	A
1576	5.7	A
1579	16.0	A
1579	16.0	A
1579	15.0	A
1582	2.0	B
1592	9.0	A
1628	6.3	A
1628	5.0	A
1628	5.8	A
1638	12.0	A
1640	11.1	A
1649	7.7	A
1658	16.0	A
1658	17.0	A
1675	9.8	A

1680	12.8	A
1680	14.1	A
1680	12.1	A
1715	15.8	A
1717	5.9	A
1717	6.9	A
1717	11.8	A
1718	8.0	A
1718	15.5	A
1718	4.0	A
1720	18.0	A
1727	16.0	A
1727	17.2	A
1734	14.0	A
1734	12.0	A
1734	8.0	A
1737	5.6	A
1745	14.3	A
1759	8.6	A
1759	7.8	A
1759	6.5	A
1761	7.6	A
1761	6.7	A
1761	11.4	A
1764	3.5	A
1764	9.8	A
1764	9.4	A
1767	4.3	A
1767	11.1	A
1767	5.5	A
1768	8.8	A
1774	16.9	A
1774	14.5	A
1776	14.0	A
1812	9.5	A
1812	10.0	A
1812	11.0	A
1814	11.6	A
1826	5.8	A
1830	8.4	A
1830	13.9	A
1830	7.9	A
1831	9.1	A
1831	13.4	A
1831	8.4	A
1832	8.0	A

2168	14.0	A
2199	7.0	A

Mean	10.2
Median (Ref)	9.5
STDev	3.9
Min	2.0
Max	18.0

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
25.4	2.3	0.6	40.7	<0.6	>40.7

Sample 2 (9SEM2) - Medium density (39.9 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	40.8	A
7	34.9	A
139	53.7	A
139	74.8	B
300	36.0	A
709	55.5	A
807	32.1	A
807	36.8	A
818	46.2	A
1181	62.1	A
1187	32.6	A
1267	35.0	A
1445	38.0	A
1456	42.8	A
1458	52.4	A
1458	53.8	A
1458	39.9	A
1507	102.9	C
1546	34.1	A
1558	37.0	A
1562	45.8	A
1569	46.5	A
1575	35.7	A
1575	20.1	B
1575	22.9	A
1576	39.2	A
1576	69.5	B

1579	42.5	A
1579	42.5	A
1579	43.5	A
1582	2.0	C
1592	38.0	A
1628	27.9	A
1628	27.9	A
1628	28.9	A
1638	65.5	A
1640	36.7	A
1649	35.7	A
1658	44.5	A
1658	47.0	A
1675	41.6	A
1680	58.5	A
1680	45.6	A
1680	62.2	A
1715	55.5	A
1717	23.6	A
1717	13.8	C
1717	41.4	A
1718	38.0	A
1718	54.0	A
1718	42.0	A
1720	54.0	A
1727	45.3	A
1727	48.1	A
1734	27.0	A
1734	49.0	A
1734	35.0	A
1737	52.8	A
1745	33.3	A
1759	29.3	A
1759	42.2	A
1759	28.9	A
1761	26.7	A
1761	27.6	A
1761	21.9	B
1764	35.0	A
1764	33.9	A
1764	38.9	A
1767	18.1	B
1767	35.4	A
1767	23.5	A
1768	39.5	A
1774	50.6	A

1774	36.0	A
1776	51.0	A
1812	48.5	A
1812	44.5	A
1812	42.0	A
1814	44.3	A
1826	22.8	A
1830	52.6	A
1830	66.5	A
1830	72.9	B
1831	32.2	A
1831	43.2	A
1831	29.5	A
1832	33.0	A
2168	40.0	A
2199	39.0	A

Mean	41.3
Median (Ref)	39.9
STDev	14.5
Min	2.0
Max	102.9

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
22.5	68.5	15.8	92.5	<15.8	>92.5

Sample 3 (9SEM3) - Medium density (27.3 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	27.5	A
7	28.0	A
139	29.5	A
139	37.5	A
300	20.0	A
709	34.5	A
807	26.3	A
807	23.3	A
818	15.1	A
1181	34.8	A
1187	23.7	A
1267	26.0	A

1445	33.0	A
1456	16.0	A
1458	34.6	A
1458	36.5	A
1458	31.3	A
1507	47.9	A
1546	31.3	A
1558	32.0	A
1562	30.1	A
1569	33.0	A
1575	20.1	A
1575	16.5	A
1575	24.7	A
1576	42.2	A
1579	38.5	A
1579	39.0	A
1579	37.5	A
1582	2.0	C
1592	32.0	A
1628	17.1	A
1628	17.9	A
1628	18.2	A
1638	51.5	A
1640	27.0	A
1649	18.8	A
1658	40.0	A
1658	34.5	A
1675	24.5	A
1680	46.8	A
1680	51.9	B
1680	34.7	A
1715	27.7	A
1717	8.9	B
1717	9.8	B
1717	20.7	A
1718	30.0	A
1718	47.0	A
1718	19.5	A
1720	40.0	A
1727	31.9	A
1727	30.9	A
1734	14.0	A
1734	25.0	A
1734	26.0	A
1737	21.7	A
1745	23.8	A

1759	19.8	A
1759	26.7	A
1759	16.8	A
1761	21.0	A
1761	22.9	A
1761	26.7	A
1764	19.5	A
1764	10.8	B
1764	26.6	A
1767	8.6	B
1767	24.7	A
1767	19.5	A
1768	24.1	A
1774	30.3	A
1774	31.0	A
1776	32.0	A
1812	28.0	A
1812	26.0	A
1812	24.0	A
1814	30.0	A
1826	14.4	A
1830	34.7	A
1830	46.6	A
1830	50.6	A
1831	29.6	A
1831	28.6	A
1831	22.8	A
1832	21.0	A
2168	38.0	A
2199	28.0	A

Mean	27.8
Median (Ref)	27.3
STDev	10.1
Min	2.0
Max	51.9

RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
51.6	8.3	72.7	<8.3	>72.7

APPENDIX 1

Sample 4 (9SEM4) - Medium density (48.9 fibres/mm^2) - amosite fibres

LAB NUMBER	TOTAL ASBESTOS	BAND (RICE)
7	63.0	A
7	51.6	A
139	54.6	A
139	86.0	B
300	49.0	A
709	50.5	A
807	37.9	A
807	40.8	A
818	71.3	A
1181	66.0	A
1187	37.9	A
1267	43.0	A
1445	50.0	A
1456	87.7	B
1458	66.8	A
1458	69.2	A
1458	61.5	A
1507	84.1	B
1546	48.3	A
1558	45.0	A
1562	44.5	A
1569	69.5	A
1575	45.7	A
1575	16.5	C
1575	43.9	A
1576	64.8	A
1579	60.0	A
1579	57.5	A
1579	58.0	A
1582	2.0	C
1592	69.0	A
1628	41.1	A
1628	54.2	A
1628	51.1	A
1638	63.5	A
1640	52.1	A
1649	51.8	A
1658	4.0	C
1658	2.0	C
1675	51.0	A
1680	67.1	A
1680	89.9	B

1680	71.9	A
1715	75.3	A
1717	11.8	C
1717	13.8	C
1717	47.3	A
1718	59.0	A
1718	44.5	A
1718	44.0	A
1720	61.0	A
1727	49.5	A
1727	47.2	A
1734	23.0	B
1734	45.0	A
1734	48.0	A
1737	40.0	A
1745	57.1	A
1759	28.4	B
1759	25.9	B
1759	25.0	B
1761	29.5	A
1761	42.9	A
1761	34.3	A
1764	42.9	A
1764	39.3	A
1764	48.8	A
1767	15.2	C
1767	35.6	A
1767	35.0	A
1768	38.6	A
1774	51.6	A
1774	39.5	A
1776	74.0	A
1812	58.0	A
1812	47.5	A
1812	52.0	A
1814	61.2	A
1826	34.0	A
1830	83.3	B
1830	79.9	A
1830	76.4	A
1831	41.0	A
1831	49.5	A
1831	29.6	A
1832	42.0	A
2168	60.0	A
2199	40.0	A

Mean	49.1
Median (Ref)	48.9
STDev	19
Min	2.0
Max	89.9

RICE A (Lower)	RICE A (Upper)	RICE B (Lower)	RICE B (Upper)	RICE C (Lower)	RICE C (Upper)
29.4	80.2	21.6	105.9	<21.6	>105.9

APPENDIX 2

DATA ANALYSIS

Regular Inter-laboratory Counting Exchange (RICE) Criteria

Where **R** is the reference value – in this case the Median value.

High density samples ($R > 63.7$ fibres/mm^2)

Target band A: $> 0.65R$ to $<1.55R$

Target band B: $> 0.50R$ to $0.65R$ [band -B] and $> 1.55R$ to $2.00R$ [band +B]

Target band C: $< 0.50R$ [band -C] and $> 2.00R$ [band +C]

Low density samples ($R \leq 63.7$ fibres/mm^2)*

Target band A: $(\sqrt{R}-1.57)^2$ to $(\sqrt{R}+1.96)^2$ [band A]

Target band B: $<(\sqrt{R}-2.34)^2$ to $(\sqrt{R}-1.57)^2$ [band -B]
$>(\sqrt{R}+1.96)^2$ to $(\sqrt{R}+3.30)^2$ [band +B]

Target band C: $<(\sqrt{R}-2.34)^2$ [band -C]
$>(\sqrt{R}+3.30)^2$ [band +C]

* For samples less than 5.5 fibres/mm^2 the lower limit is set to zero when the component within the brackets ($\sqrt{R}$-n) is less than zero.

The plot below shows the positions of the performance limits in relation to the reference counts up to reference density 500 fibres/mm^2.